LM79XX Series 3-Terminal Negative Regulators

Check for Samples: **LM7905**, **LM7912**, **LM7915**

FEATURES

- **Thermal, Short Circuit and Safe Area Protection**
- **High Ripple Rejection**
- **1.5A Output Current**
- **4% Tolerance on Preset Output Voltage**

DESCRIPTION

The LM79XX series of 3-terminal regulators is available with fixed output voltages of −5V, −12V, and −15V. These devices need only one external component—a compensation capacitor at the output. The LM79XX series is packaged in the TO-220 power package and is capable of supplying 1.5A of output current.

These regulators employ internal current limiting safe area protection and thermal shutdown for protection against virtually all overload conditions.

Low ground pin current of the LM79XX series allows output voltage to be easily boosted above the preset value with a resistor divider. The low quiescent current drain of these devices with a specified maximum change with line and load ensures good regulation in the voltage boosted mode.

For applications requiring other voltages, see LM137 datasheet.

Connection Diagram

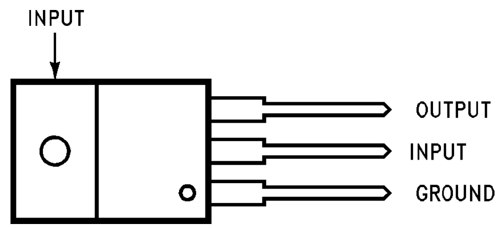
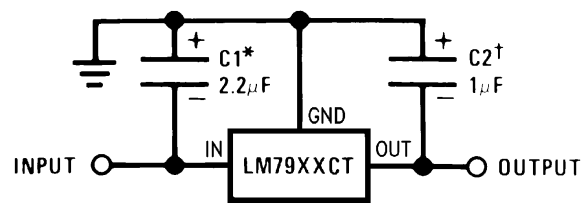


Figure 1. TO-220 Package Front View See Package Number NDE0003B

Typical Applications



*Required if regulator is separated from filter capacitor by more than 3″. For value given, capacitor must be solid tantalum. 25μF aluminum electrolytic may be substituted.

†Required for stability. For value given, capacitor must be solid tantalum. 25μF aluminum electrolytic may be substituted. Values given may be increased without limit.

For output capacitance in excess of 100μF, a high current diode from input to output (1N4001, etc.) will protect the regulator from momentary input shorts.

Figure 2. Fixed Regulator

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS[1]

Input Voltage	
(V_o = −5V)	−25V
(V_o = −12V and −15V)	−35V
Input-Output Differential	
(V_o = −5V)	25V
(V_o = −12V and −15V)	30V
Power Dissipation [2]	Internally Limited
Operating Junction Temperature Range	0°C to +125°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	230°C

(1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not ensure Specific Performance limits. For ensured specifications and test conditions, see the Electrical Characteristics.
(2) Refer to DESIGN CONSIDERATIONS for details.

ELECTRICAL CHARACTERISTICS

Conditions unless otherwise noted: I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1μF, 0°C ≤ T_J ≤ +125°C, Power Dissipation ≤ 1.5W.

Part Number			LM7905C			Units
Output Voltage			−5V			
Input Voltage (unless otherwise specified)			−10V			
Symbol	Parameter	Conditions	Min	Typ	Max	
V_O	Output Voltage	T_J = 25°C	−4.8	−5.0	−5.2	V
		5mA ≤ I_{OUT} ≤ 1A,	−4.75		−5.25	V
		P ≤ 15W		(−20 ≤ V_{IN} ≤ −7)		V
ΔV_O	Line Regulation	T_J = 25°C, [1]		8	50	mV
				(−25 ≤ V_{IN} ≤ −7)		V
				2	15	mV
				(−12 ≤ V_{IN} ≤ −8)		V
ΔV_O	Load Regulation	T_J = 25°C, [1]				
		5mA ≤ I_{OUT} ≤ 1.5A		15	100	mV
		250mA ≤ I_{OUT} ≤ 750mA		5	50	mV
I_Q	Quiescent Current	T_J = 25°C		1	2	mA
ΔI_Q	Quiescent Current Change	With Line			0.5	mA
				(−25 ≤ V_{IN} ≤ −7)		V
		With Load, 5mA ≤ I_{OUT} ≤ 1A			0.5	mA
V_n	Output Noise Voltage	T_A = 25°C, 10Hz ≤ f ≤ 100Hz		125		μV
	Ripple Rejection	f = 120Hz	54	66		dB
				(−18 ≤ V_{IN} ≤ −8)		V
	Dropout Voltage	T_J = 25°C, I_{OUT} = 1A		1.1		V
I_{OMAX}	Peak Output Current	T_J = 25°C		2.2		A
	Average Temperature Coefficient of Output Voltage	I_{OUT} = 5mA, 0 C ≤ T_J ≤ 100°C		0.4		mV/°C

(1) Regulation is measured at a constant junction temperature by pulse testing with a low duty cycle. Changes in output voltage due to heating effects must be taken into account.

ELECTRICAL CHARACTERISTICS

Conditions unless otherwise noted: I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1μF, 0°C ≤ T_J ≤ +125°C, Power Dissipation ≤ 1.5W.

Part Number			LM7912C			LM7915C			Units
Output Voltage				−12V			−15V		
Input Voltage (unless otherwise specified)				−19V			−23V		
Symbol	Parameter	Conditions	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	T_J = 25°C	−11.5	−12.0	−12.5	−14.4	−15.0	−15.6	V
		5mA ≤ I_{OUT} ≤ 1A,	−11.4		−12.6	−14.25		−15.75	V
		P ≤ 15W		(−27 ≤ V_{IN} ≤ −14.5)			(−30 ≤ V_{IN} ≤ −17.5)		V
ΔV_O	Line Regulation	T_J = 25°C, (1)		5	80		5	100	mV
				(−30 ≤ V_{IN} ≤ −14.5)			(−30 ≤ V_{IN}≤ −17.5)		V
				3	30		3	50	mV
				(−22 ≤ V_{IN} ≤ −16)			(−26 ≤ V_{IN} ≤−20)		V
ΔV_O	Load Regulation	T_J = 25°C, (1)							
		5mA ≤ I_{OUT} ≤ 1.5A		15	200		15	200	mV
		250mA ≤ I_{OUT} ≤ 750mA		5	75		5	75	mV
I_Q	Quiescent Current	T_J = 25°C		1.5	3		1.5	3	mA
ΔI_Q	Quiescent Current	With Line			0.5			0.5	mA
	Change			(−30 ≤ V_{IN} ≤ −14.5)			(−30 ≤V_{IN} ≤ −17.5)		V
		With Load, 5mA ≤ I_{OUT} ≤ 1A			0.5			0.5	mA
V_n	Output Noise Voltage	T_A = 25°C, 10Hz ≤ f ≤ 100Hz		300			375		μV
	Ripple Rejection	f = 120 Hz	54	70		54	70		dB
				(−25 ≤ V_{IN} ≤ −15)			(−30 ≤ V_{IN}≤ −17.5)		V
	Dropout Voltage	T_J = 25°C, I_{OUT} = 1A		1.1			1.1		V
I_{OMAX}	Peak Output Current	T_J = 25°C		2.2			2.2		A
	Average Temperature Coefficient of Output Voltage	I_{OUT} = 5mA, 0 C ≤ T_J ≤ 100°C		−0.8			−1.0		mV/°C

(1) Regulation is measured at a constant junction temperature by pulse testing with a low duty cycle. Changes in output voltage due to heating effects must be taken into account.

DESIGN CONSIDERATIONS

The LM79XX fixed voltage regulator series has thermal overload protection from excessive power dissipation, internal short circuit protection which limits the circuit's maximum current, and output transistor safe-area compensation for reducing the output current as the voltage across the pass transistor is increased.

Although the internal power dissipation is limited, the junction temperature must be kept below the maximum specified temperature (125°C) in order to meet data sheet specifications. To calculate the maximum junction temperature or heat sink required, the following thermal resistance values should be used:

Package	Typ θ_{JC} °C/W	Max θ_{JC} °C/W	Typ θ_{JA} °C/W	Max θ_{JA} °C/W
TO-220	3.0	5.0	60	40

$$P_{D\,MAX} = \frac{T_{J\,Max} - T_A}{\theta_{JC} + \theta_{CA}} \text{ or } \frac{T_{J\,Max}\ T_A}{\theta_{JA}}$$

$$\theta_{CA} = \theta_{CS} + \theta_{SA} \text{ (without heat sink)} \quad (1)$$

Solving for T_J:

$T_J = T_A + P_D (\theta_{JC} + \theta_{CA})$

or

$= T_A + P_D\theta_{JA}$ (without heat sink)

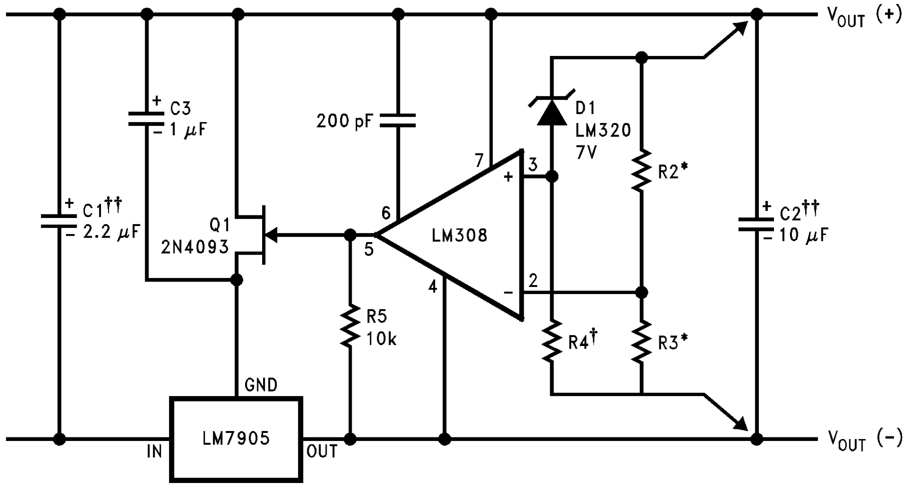
where

- T_J = Junction Temperature
- T_A = Ambient Temperature
- P_D = Power Dissipation
- θ_{JA} = Junction-to-Ambient Thermal Resistance
- θ_{JC} = Junction-to-Case Thermal Resistance
- θ_{CA} = Case-to-Ambient Thermal Resistance
- θ_{CS} = Case-to-Heat Sink Thermal Resistance
- θ_{SA} = Heat Sink-to-Ambient Thermal Resistance

Typical Applications

Bypass capacitors are necessary for stable operation of the LM79XX series of regulators over the input voltage and output current ranges. Output bypass capacitors will improve the transient response by the regulator.

The bypass capacitors, (2.2μF on the input, 1.0μF on the output) should be ceramic or solid tantalum which have good high frequency characteristics. If aluminum electrolytics are used, their values should be 10μF or larger. The bypass capacitors should be mounted with the shortest leads, and if possible, directly across the regulator terminals.



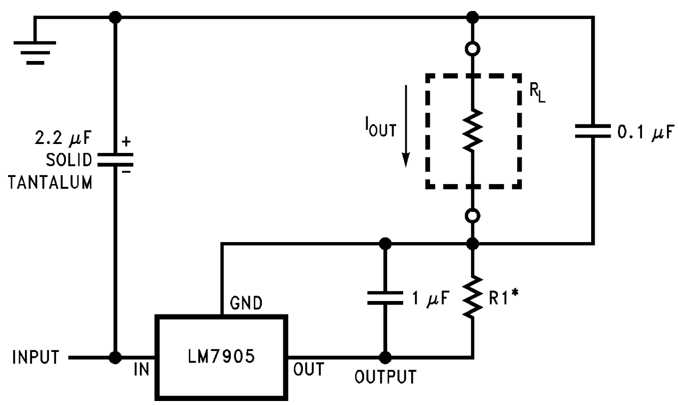
Load and line regulation < 0.01% temperature stability ≤ 0.2%

†Determine Zener current

††Solid tantalum

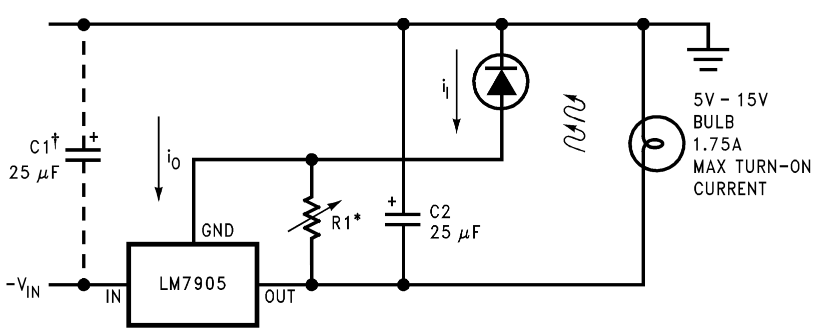
*Select resistors to set output voltage. 2 ppm/°C tracking suggested

Figure 3. High Stability 1 Amp Regulator



$^*I_{OUT} = 1\text{ mA} + \frac{5V}{R1}$

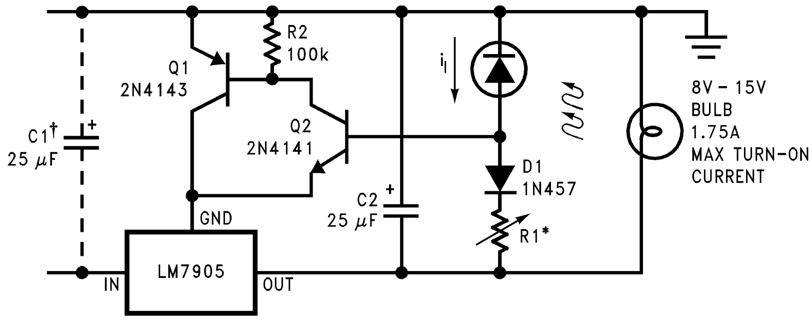
Figure 4. Current Source



*Lamp brightness increase until $i_I = i_Q$ (≈ 1 mA) + 5V/R1.

†Necessary only if raw supply filter capacitor is more that 2″ from LM7905CT

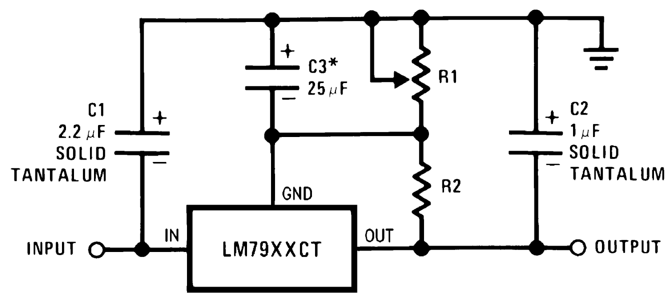
Figure 5. Light Controller Using Silicon Photo Cell



*Lamp brightness increases until i_i = 5V/R1 (I_i can be set as low as 1 μA)

†Necessary only if raw supply filter capacitor is more that 2″ from LM7905

Figure 6. High-Sensitivity Light Controller



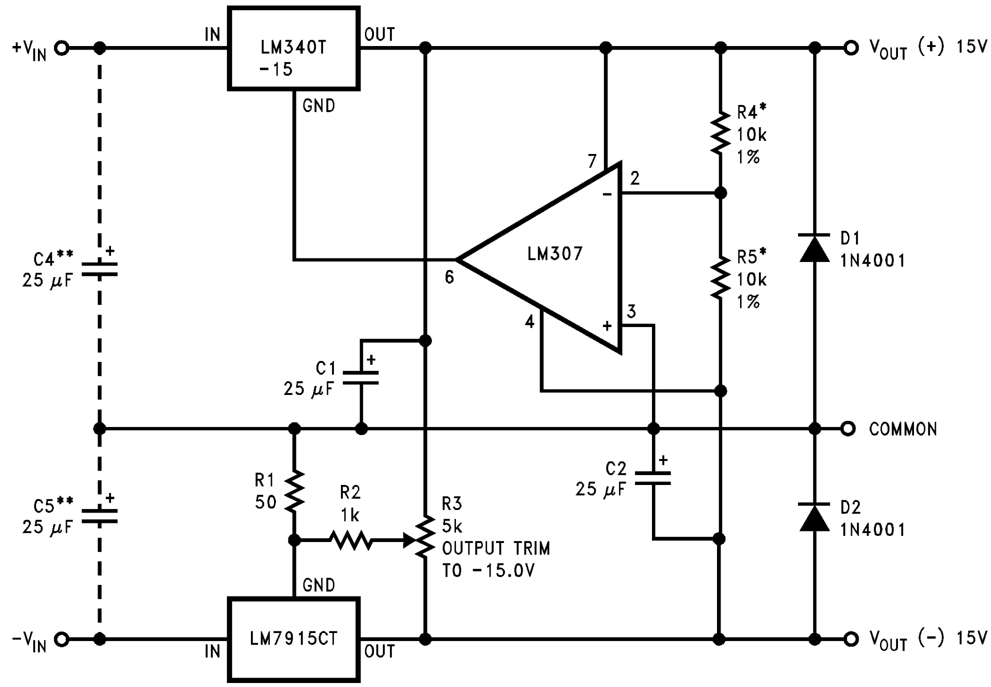
*Improves transient response and ripple rejection. Do not increase beyond 50 μF.

$$V_{OUT} = V_{SET}\left(\frac{R1 + R2}{R2}\right)$$

Select R2 as follows:

LM7905CT	300Ω
LM7912CT	750Ω
LM7915CT	1k

Figure 7. Variable Output



	(-15)	(+15)
Load Regulation at ΔI_L = 1A	40mV	2mV
Output Ripple, C_{IN} = 3000µF, I_L = 1A	100 µVms	100 µVms
Temperature Stability	50mV	50mV
Output Noise 10Hz ≤ f ≤ 10kHz	150 µVms	150 µVms

*Resistor tolerance of R4 and R5 determine matching of (+) and (−) outputs.

**Necessary only if raw supply filter capacitors are more than 3″ from regulators.

Figure 8. ±15V, 1 Amp Tracking Regulators

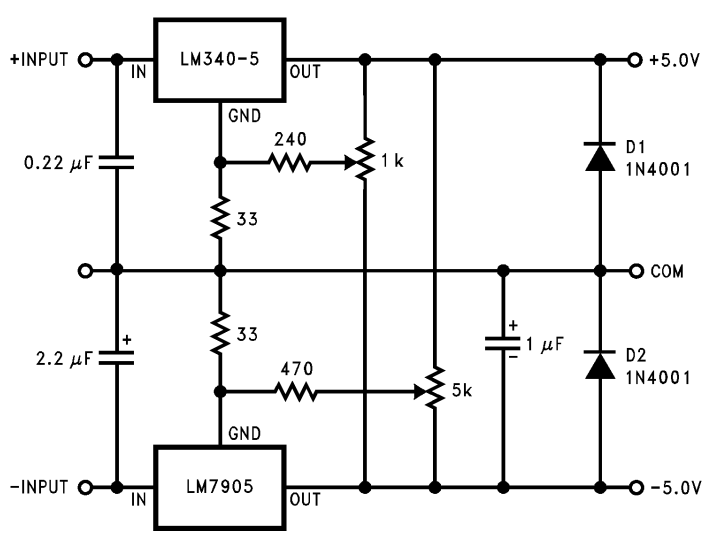


Figure 9. Dual Trimmed Supply

Schematic Diagrams

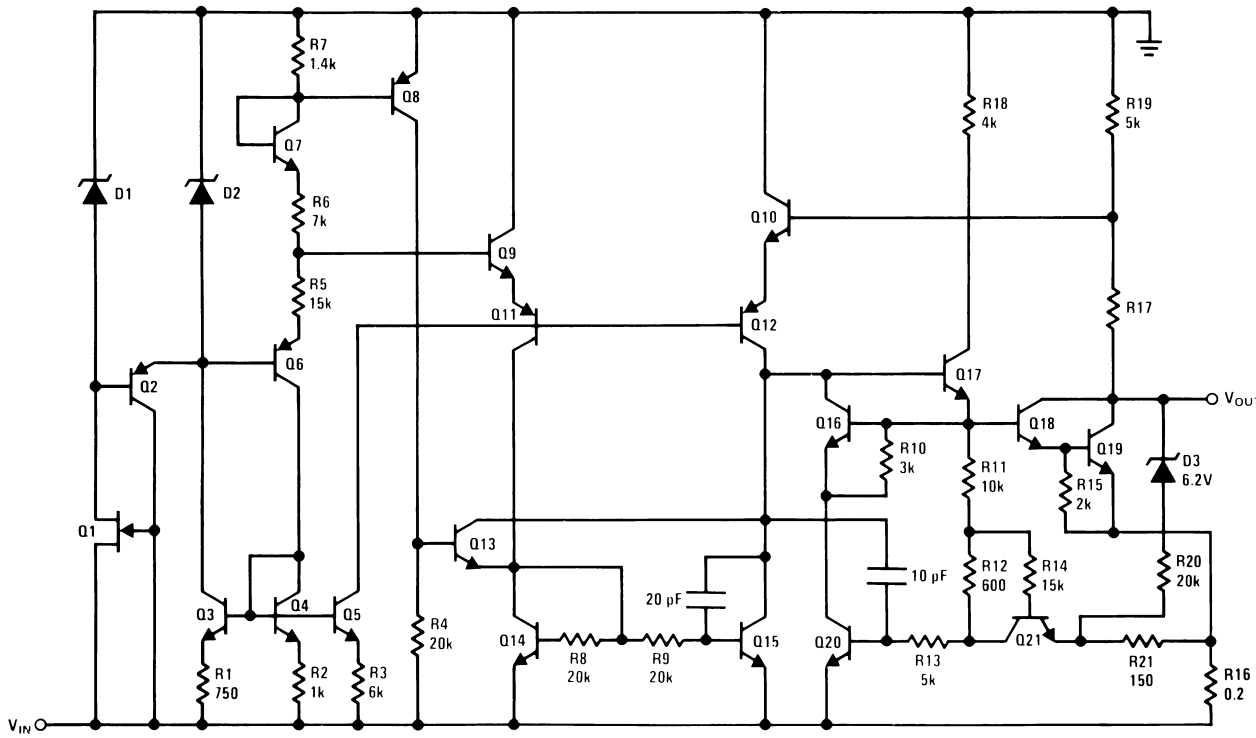


Figure 10. −5V

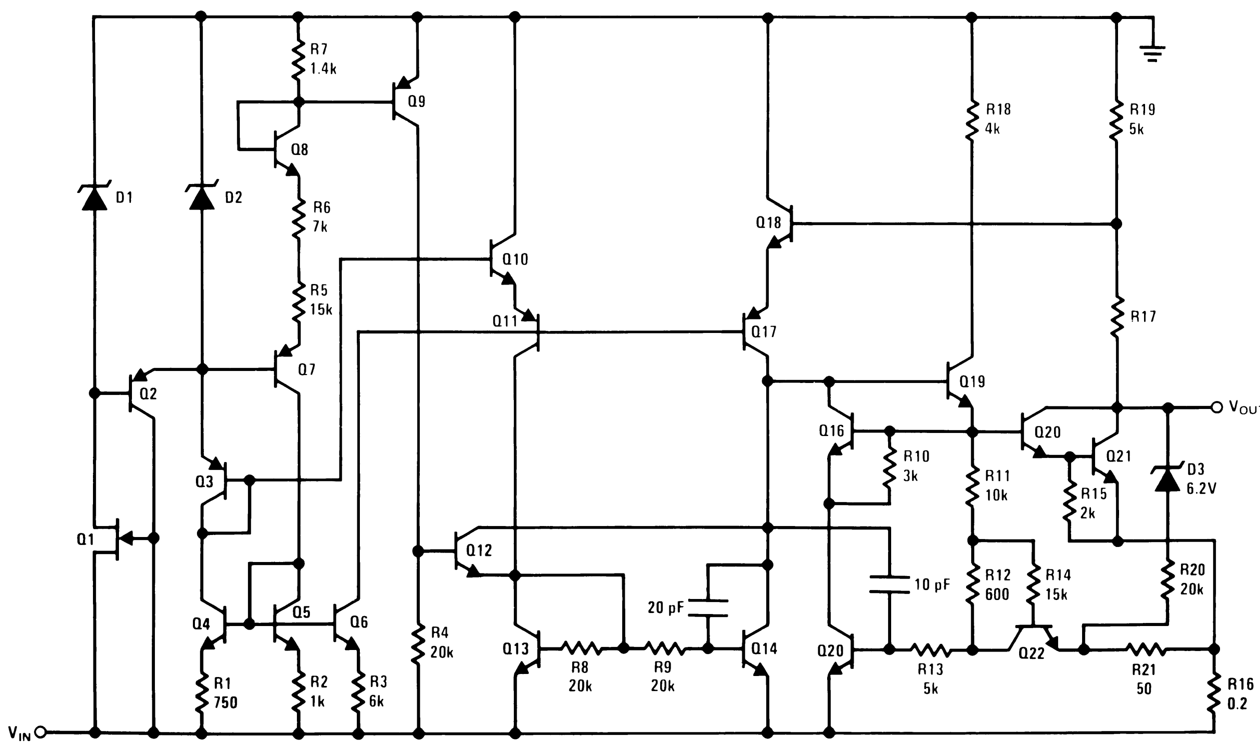


Figure 11. −12V and −15V

REVISION HISTORY

Changes from Revision B (May 2013) to Revision C	Page
• Changed layout of National Data Sheet to TI format.	8

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
LM7905CT	NRND	TO-220	NDE	3	45	TBD	Call TI	Call TI	0 to 125	LM7905CT	
LM7905CT/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	0 to 125	LM7905CT	Samples
LM7912CT	NRND	TO-220	NDE	3	45	TBD	Call TI	Call TI	0 to 125	LM7912CT	
LM7912CT/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	0 to 125	LM7912CT	Samples
LM7915CT	NRND	TO-220	NDE	3	45	TBD	Call TI	Call TI	0 to 125	LM7915CT	
LM7915CT/NOPB	ACTIVE	TO-220	NDE	3	45	Green (RoHS & no Sb/Br)	CU SN	Level-1-NA-UNLIM	0 to 125	LM7915CT	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

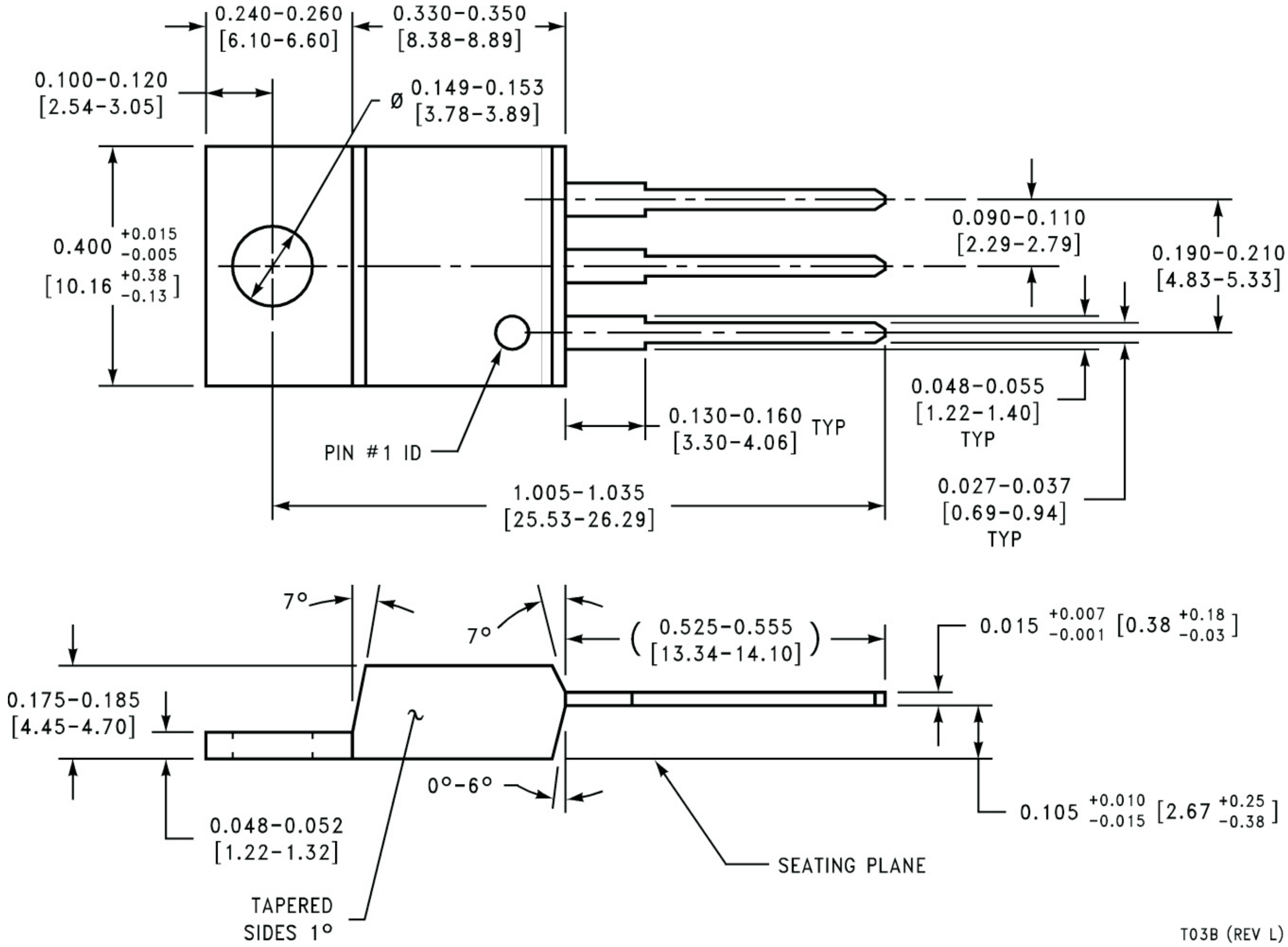
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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NDE0003B


0.240–0.260
[6.10–6.60]
0.330–0.350
[8.38–8.89]
0.100–0.120
[2.54–3.05]
Ø 0.149–0.153
[3.78–3.89]
0.400 +0.015 −0.005
[10.16 +0.38 −0.13]
0.090–0.110
[2.29–2.79]
0.190–0.210
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0.048–0.055
[1.22–1.40]
TYP
0.130–0.160 TYP
[3.30–4.06]
PIN #1 ID
1.005–1.035
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[0.69–0.94]
TYP
7°
7°
(0.525–0.555
[13.34–14.10])
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0.175–0.185
[4.45–4.70]
0°–6°
0.105 +0.010 −0.015 [2.67 +0.25 −0.38]
0.048–0.052
[1.22–1.32]
SEATING PLANE
TAPERED
SIDES 1°
T03B (REV L)

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